

Comparative assessment of five tested sorting technologies



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Action 4.2

Quality assurance

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1 BACKGROUND

In this report we have investigated available sorting technologies.

In the first report on action 4.2, *Test notes on practical test and demonstration activities*, we have tested five sorting facilities. Two of these were considered typical sorting facilities (Veolia-Rostock and DK Raastoffer) although one of them does not currently receive rigid household plastics from households, and two facilities are considered having an above average recovery rate (Augustin and ALBA), and Steinert Global, a test facility for the company's NIR technology.

This report is the second deliverable for Action 4.2: a comparative assessment of the tested technologies. In line with the overall aim of the Plastic Zero project, the purpose of the tests and the assessment is to gain information on how to achieve the highest possible recycling rate of collected household rigid waste plastics. The results of the comparative assessment can be used to evaluate specific facilities that may be viable options for treating of the waste plastics from the City of Copenhagen, but may also be used to suggest possible criteria for tenders for sorting of waste plastics.

2 PURPOSE

The purpose of the action has been:

- To analyse the present options for recycling and determine the need for innovation of new technologies and systems for recycling of the specific waste materials.
- To compare cost and CO₂-emissions from transportation to each facility
- To use the comparative assessment and test results to suggest possible criteria which could implemented in tenders.

3 COMPARATIVE ASSESSMENT

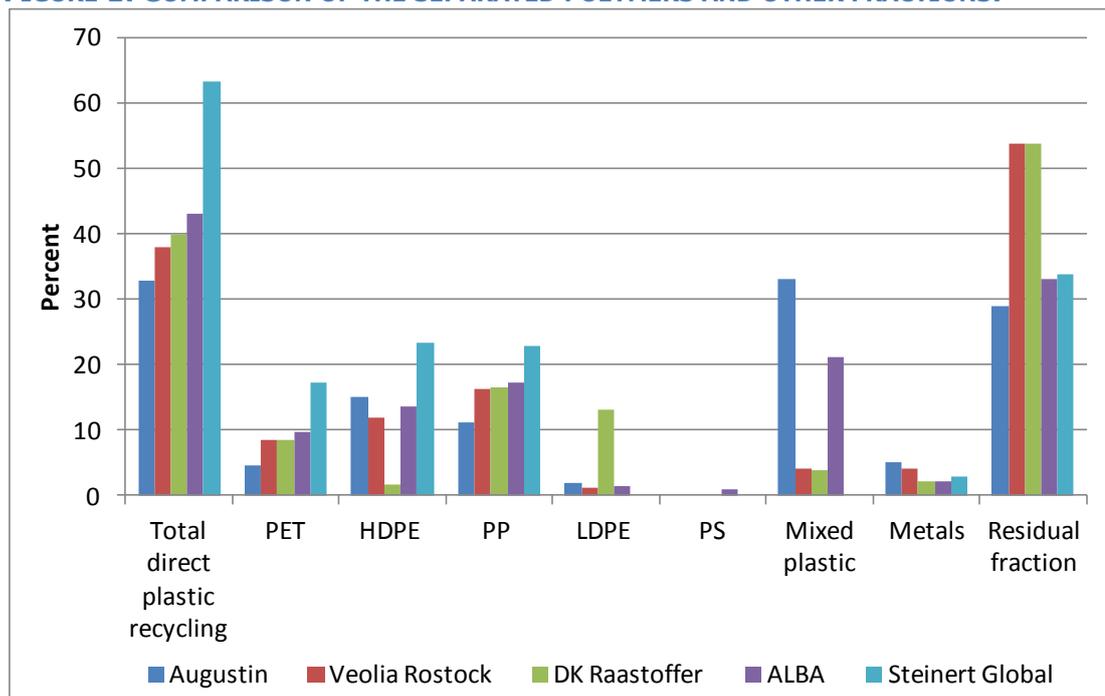
Comparing the results of the sorted polymers between the five facilities, we observe, in Figure 1, that there are some general trends. The actual plastic recycling rates seem to be in the area of 33-43% at a full-scale plastic recycling facility. The results from Steinert Global's test facility showed a sorting efficiency of 63%, and the facility sorted out more of each fraction.

There seem to be fairly equal amounts of PET, HDPE and PP in the waste plastics. Otherwise observable is that Augustin sorted a large part as mixed plastic, why their residual fraction is lower. ALBA also sorted around 20 percent as mixed plastic. This mixed plastic is said to be sorted further, but the result of this sorting is unknown.

Likewise, the contents of the residual fraction are unknown. The facilities have identified items that pose a challenge in sorting process such as video tapes, large items (usually over 400 mm), PVC, WEEE and textiles.

A manual sorting of the rigid waste plastics from Copenhagen indicates that around 10 percent of the plastics is black. Since conventional NIR scanners are not able to identify the polymer types, if the plastic is black, this waste is likely to end up in the residual fraction (and as refuse derived fuel, RDF).

FIGURE 1. COMPARISON OF THE SEPARATED POLYMERS AND OTHER FRACTIONS.



Note: Steinert Global sorted HDPE and LDPE into the same fraction, why this is depicted as HDPE in the graph. Data on Augustin, Veolia Rostock and ALBA has been provided by Marius Pedersen A/S.

Most of the parameters in Table 1 are self explanatory. However, there are a few where the parameters themselves and the reasons behind needs to be explained, which are explained in the following parts.

TABLE 1. COMPARATIVE ASSESSMENT OF THE TESTED TECHNOLOGIES

Company	Veolia Rostock	DK Raastoffer	Augustin	ALBA	Steinert Global
Location	Rostock, Germany	Fredericia, Denmark	Meppen, Germany	Braunschweig, Germany	Cologne, Germany
Batch size [tonnes]	16.08	36.54	181.86	92.24	0.2
Distance to facility [km] truck/ferry	185/35	215/0	550/19	508/19	720/30
Receives plastic waste in bales?	Yes	Yes	Yes	Yes	No ¹
Receives mixed plastics from households?	Yes	No	Yes	Yes	-
Sorting? Reprocessing into flakes, pellets, granulates?	Yes. No	Yes. No	Yes. No	Yes. No	Yes. No
Direct plastic recovery rate obtained at the facility [%]	38%	40%	33%	43%	63%
Total recovery, incl. mixed plastics	42%	44%	66%	64%	63%
Separated plastic types	PET, HDPE, PP, LDPE	PET, HDPE, PP	PET, HDPE, PP, LDPE	PET, PE, PP, HDPE, LDPE, PS ⁴	PET, PE, PP
Residual fraction sent directly for incineration [%]	52%	53%	29%	28%	34%
Does the company make it	Not clear	Not clear	Not clear	Not clear	-

¹ Steinert Global is a test facility. It thus required that the batch is only 200 kg with the items having a maximum size of 400 mm. Data on Augustin, Veolia Rostock and ALBA has been provided by Marius Pedersen A/S.

Company	Veolia Rostock	DK Raa-stoffer	Augustin	ALBA	Steinert Global
possible to trace the out-sorted plastic material until it reaches the form of pellet-material?					
Test price [EUR/tonne]	108	Unknown	147 ³	173	Unknown
Transportation [EUR/tonne]	25	20	Included	Included	1,485
Transportation [kg CO ₂ /tonne]	36	41	105	97	137
Visited by Plastic Zero project partners?	Yes	Yes	No	No ¹	Yes

Note: 1. Visited by Marius Pedersen. 2. Data from Bigum (2013) used to calculate CO₂ emissions from transportation; 0.19 kg CO₂/km/tonne for truck and 0.02 kg CO₂/km/tonne. 3. Augustin had a batch test fee of EUR 750 which is not included. 4. Will also be able to sort black plastics from end August.

3.1 Sorting? Reprocessing into flakes or pellets?

Recycling of plastic waste into new materials can occur in many steps. First step will typically be sorting followed by reprocessing into flakes, pellets, granulates or other. Reprocessing is a necessary step for upgrading waste material into raw material that can substitute virgin plastic material. Most facilities will not conduct both the sorting and the reprocessing. This is important to consider when evaluating the recovery rate of a facility. Rejects are produced in most steps. A facility that only conducts an initial sorting (e.g. simply removes PET) and then directs the remaining waste plastics for recycling, could therefore appear to have a high recovery rate, if the remaining mixed plastic fraction is considered as "100% recycled" even though it is likely that the actual recovery rate of the mixed plastic fraction is somewhat lower.

Theoretically, the more a facility reprocesses the plastic waste, the higher likelihood that the plastics are actually recycled and not subsequently used as fuel, which again relates to the traceability issue. It would make little sense to make an effort to reprocess a material and then send it to an RDF facility or incineration plant.

3.2 Direct recovery rate obtained at the facility [%]

The "direct recovery rate" issues are related to the issues as mentioned above. The "direct recovery rate" refers to the share of plastic material which is directly sorted as separate plastic types (e.g. PET, PE, and PP respectively) at the facility. Mixed plastic which would need additional sorting elsewhere and is not included in the "direct recovery rate". The polymers separated at the facilities are mainly PET (bottles mostly), HDPE and PP. One plant sorted LDPE and another PS (in a very small amount).

3.3 Out-sorted plastic types

The types of plastics that a facility sorts out for reprocessing are determined by many factors. The market potential of the plastic type (is there a buyer?), the price which can be obtained for the material (is the profit to be made high enough?), the political set of recycling targets, and if there is a large enough quantity of the polymer (how small a quantity does it make sense to sort?). Finally, there may be technological issues that hinder the recovery of plastic such as the case with black plastic material.

Some plastic types are recoverable, e.g. PS, PC, PVC and certain bioplastics, but for various reasons the sorting facility chooses not to sort these out. These would then end up in the reject fraction. Knowing what plastic types a facility sorts out is one possibility to evaluate if a facility is ambitious with regard to ensuring high recovery rates.

3.4 Residual fraction sent directly for RDF/incineration [%]

The fraction used for fuel or sent for incineration indicates the level of ambitious recycling taking place at the facility as with the parameters regarding "Separated plastic types" and "Residual fraction sent for incineration". The residual fraction could consist of other materials than plastic e.g. misplaced items such as metals, cardboard or wood. This should be taken into account when evaluating the size of the residual fraction, so this represents only the plastics. An evaluation of the content of the reject fractions has however proven hard to obtain (see the Test notes report).

3.5 Does the company make it possible to trace the out-sorted plastic material until it reaches the form of pellet-material?

Tracing the waste plastics to the point where a recycled plastic material has actually been produced is vital to determine the actual recovery rate. "Sent to a recycling facility" is not the same as "recycled".

This is in line with the proposal from the European Commission in its Circular Economy Package. The proposal for amended directives includes a suggestion to harmonise and streamline the calculation of targets. In the proposal, the weight of waste prepared for re-use and recycling shall be understood as the weight of the waste put into a final preparing for re-use or recycling process less the weight of any materials which were discarded in the course of that process due to presence which need to be disposed of or undergo other recovery operations. In other words, only the net recycling of materials will be considered recycling whereas the amount of materials collected for recycling will no longer be considered as 100% recycling.

Traceability is also to the general public an important factor as it would be a fair demand that the public would want to know that the waste plastics they spend their time and effort to sort for recycling are actually recycled. However, tracing the material is often not possible, many steps occur before a material is finally reprocessed into a new raw material and the recipients differ as the waste material is traded and the price someone is willing to pay is the determining factor. This is a dilemma and finding a compromise is necessary. Some of the other parameters described above might be possibilities of this.

4 POSSIBLE CRITERIA FOR TENDERS

In this section we present a set of criteria that could serve as a point of departure in the definition of tender criteria for the sorting of waste plastics from households. Clearly, the criteria will depend on whether the waste plastics comprises plastic packaging only or also comprises other kinds of plastic items. Below, we have chosen a wider definition of waste plastics.

- 1) It is the City of XX, who determines the definition of waste plastics which are collected and what is considered as recyclable.
Justification: We would not want to be in a situation where the sorting facility determines that the PP or empty paint buckets for example cannot be described as being recyclable. Of course, we must be responsive to real problematic waste plastics, such as the black plastic or VHS tapes.
- 2) The sorting facility must be able to demonstrate a genuine recycling of plastic of 70%.
Justification: The test facility managed to achieve a 63% recycling rate for only three polymers (PET, HDPE and PP). If PS, PVC and black plastics (and eventually flexible plastics, LDPE) are included in the sorted polymers, a 70% sorting efficiency should be obtainable.

The European Commission has suggested a 60% recycling rate of the plastic packaging placed on the market in 2030. In order to reach this target more than 60% will need to be sorted as it is not possible to collect all the plastic packaging placed on the market (100%).

- 3) Other recyclable fractions (metal, used beverage cartons, flexible plastics/foils, etc.) must be separated and sent for recycling or further processing for recycling.
Justification: Other recyclable fractions should not occur in the plastic fraction, but it unfortunately happens anyway. The City of Copenhagen does what is possible with the information to avoid errors in sorting, but errors will unfortunately occur. This does not change that wrongly sorted recyclable fractions should be recycled.
- 4) The sorting facility must be able to account for the facility's plastic sorting efficiency with regard to each plastic polymer. In other words, the facility must be held accountable for the contents of any residual fraction incinerated or landfilled.
Justification: A plant's efficiency cannot only be measured by the size of the residual fraction as the residual fraction may contain plastics that can easily be recycled but is not due to e.g. financial reasons. The City of Copenhagen aims to ensure a high recycling, and needs in what aspects to be able to demonstrate the effectiveness of the plants we work with, to make sure that these are the most effective.
- 5) The sorting facility should at any time be able to account for the actual recycling rate, quality and destination of the sorted fractions. This also involves the recycling rate of fractions that are sent for further processing. RDF and incineration are not considered recycling.
Justification: "Received for recycling" is not the same as "actually recycled". There may be many processing stages and it is important that the recycling rate we achieve reflect plastic that is actually reprocessed for new raw material.
- 6) The sorting facility should at any time be able to provide data on the environmental performance in order for City of XX to assess if the facility complies with the tender requirements.
Justification: Local authorities are politically driven organisations and are regularly approached by politicians and citizens who want to know what happens to the waste and want to ensure that treatment follows the politically agreed objectives.
- 7) The sorting facility should at any time be able to provide samples of the recycled material for testing.
Justification: This is to ensure that a high quality recycled plastic is produced at all times.

5 DISCUSSION

The direct recovery rates of the facilities were lower than expected. The results from the test facility though showed that the technology to raise the recovery rates is available.

Setting a target recovery rate seems a possibility but in order to drive innovation and continuing progress, such a recovery rate should be raised at regular intervals.

Otherwise there is a risk that sorting facilities reach the agreed recovery rate and has no incentive to go any further.

It should be investigated if other plastic polymers than PET, HDPE, LDPE and PP could be sorted out. PVC and PS seem obvious candidates to include in the criteria for tenders, as they constitute 11 and 7% of the European plastic demand respectively (PlasticsEurope, 2013).

If the waste plastics comprise all plastic items from a typical household, i.e. also toys, household products, pipes, etc., the sorting facility need to be able to handle this. First, household products or construction-like items often include other polymer types than the typical thermoplastics, so the facility ought to be able to sort out some of these other polymers. Second, many of such items are larger than 400 mm in size and the facility should also be able to handle this.

As an additional issue, tender criteria could also include a requirement on the sorting of black plastic. The technology for this is available, albeit expensive still.

Price of sorting seems to be around 100-170 EUR/tonne. It should be mentioned though that the sorting prices obtained here were in relation to a test and that prices could very well be lower, if a contract for a period of time should be made. Carbon dioxide emissions for transportation within short distances seem insignificant compared to savings of recycling plastic. The net CO₂ savings of recycling normally range between 1.5-2 tonne per tonne plastic (BIO & Copenhagen Resource Institute, 2010) compared to incineration.

It has not been easy to obtain the required information. On some cases, it has been difficult obtain information to be able to calculate the actual recycling rates of the different facilities.

6 CONCLUSION

Recovery rates at existing sorting facilities are generally low, but technology exists to increase these rates.

In the preparation of a tender one should pay attention to definitions of terms, e.g. if recovery rates includes energy recovery. In order to be able to choose ambitious sorting facility, transparent information is necessary and so is the setting of targets for direct recovery rates.

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